BIOTECHNOLOGY AT THE FOREFRONT OF AGRICULTURE

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Why do we look at biotechnology and why will it be at the forefront of agriculture? Quite simply, all of us are directly involved with agriculture in one way or another—we all have to eat. Given that the world's population will double in the next 35 years—from 5 billion to 10 billion people, we need to be concerned about how the world's food needs will be met. In caloric terms, we will have to produce more calories in the next 35 years than we have produced since farming began 10,000 years ago. Assuming a population growing in a geometric progression and that food production is growing in an arithmetic progression, Malthus predicted that we would soon outstrip our ability to feed a growing population. Fortunately, he has been wrong for a few hundred years.

It's not what we don't know that hurts us, it's what we know that ain't true that's gonna kill us in the end.
-Jerry Caulder paraphrasing Will Rogers

Why? Because the American farmer has adopted science and technology as rapidly as it has become available, allowing farm production to outpace population growth. Advances in agricultural technology can be categorized into five distinct areas:

-Domestication of animals and plants
-Mechanization
-Hybridization or genetics
-Chemicals—pesticides and fertilizers
-Biotechnology

Biotechnology fits well with the previous four and will quickly be adopted. Interestingly, each stage of growth listed above has resulted in a higher standard of living, longer life expectancy and better and cheaper food. Our existence is now dependent on fewer than 20 species of plants—we must use all available resources to assure that species are genetically fit to survive under the wide range of environmental extremes. These 20 species must be protected from pests to assure that they can reach their full genetic potential.

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should be dependent upon so few plants, but we are. One species alone, rice, furnishes about 60 percent of the energy for half of the people on earth. Stated another way, 30 percent of the human energy in the world comes from rice. From that standpoint, we are vulnerable. We must do everything possible to protect that genome in rice, because it supplies a lot of energy. Biotechnology offers many options for achieving that goal.

Seventy percent of our food comes from five crops—five crops that stand between us and starvation. Agriculture faces a simple challenge—to continue to adopt new technologies and to encourage quantum leaps in science (such as those in biotechnology), and use that technology to stay ahead of this curve. When oil reaches $40 per barrel, it is strange how people respond by funding research on alternatives to energy, yet we continue to cut basic research dollars for agriculture. Less than a 60 days supply of food in the world is considered a surplus. Contrast that with considering a 200 year supply of oil a strategic reserve. In constant dollars, agricultural research is being funded at the same level it was in the mid 1960s. In 1939,80 percent of the federal research and development budget went to agricultural research. Today it is less than two percent.

We now have at our disposal this new science called biotechnology that will allow us to continue winning the race to produce food more efficiently, as long as this science is adequately funded.

To provide another example, does this quote sound familiar? "We have recently advanced our knowledge of genetics to a point where we can manipulate life in a way never intended by nature—we must proceed with utmost caution in the application of this new found knowledge." This quote is from 1906, from a critique of Luther Burbank s hybridization work.

The need for agricultural technology is viewed skeptically, for every trip to the grocery store finds it full of food. Many people, including my 20 year old son, think corn comes from the A&P—they have no idea where food comes from. Yet the scientific base on which this efficiency of production is based is very fragile and requires such an understanding in order to survive.

Efficiency is central to agriculture. We strive to maximize production while minimizing input. Low input sustainable agriculture is an acceptable goal only if output is not affected. We continue to tinker with the most efficient industry in the world—a system which allows 98 percent of the population to move from farms to pursue other interests, while the other two percent produces the food which allows us to do so. We are adept at telling that two percent how to run

their business.

All of the five technology categories mentioned earlier encountered considerable resistance when introduced, so what must we do to assure that biotechnology is used to advance the efficiencies of U.S. agriculture and the American farmer?

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First, we have to change our mental attitude about what we currently consider a surplus of food. This "surplus" should truly be considered a "strategic reserve." A few years ago, when we were in a drought, food prices rose five to eight percent. With the agricultural business base at around $400 billion, a five to eight percent increase in price far outstripped what it would have taken to store enough food to counterbalance the effects of the drought. The current levels of "surplus" are only inadequate "reserves."

Second, we have to increase our basic research in agriculture. A flat budget for over the last 20 years is a national shame. New dollars have to be made available to attract our finest scientists back to agriculture. Scientists, like the rest of us, tend to gravitate towards where they are appreciated most. Lack of funding in agricultural research has meant that NIH and other fields have successfully recruited the first round draft choices in medical and other research areas, rather than agriculture. We must become more competitive in order to be able to competitively bring top dollars back into agriculture. My father used to say "the actions that get rewarded get repeated." We have to start rewarding the right actions to get the right results.

Third, we must have a system of patent protection which protects intellectual property rights, and a regulatory system that allows these developing products to progress in an orderly manner to the marketplace, within a reasonable time frame at a reasonable cost. We will kill biotechnology quickly without a clear and timely regulatory process.

Last, we must continue to strive to strengthen the scientific literacy of our young people. We are a scientifically illiterate society. When a substantial portion of our population believes in pyramid and crystal power and the White House is run by an astrologist, we are in trouble. We must upgrade the scientific literacy of our young people. Vocational agriculture is not acceptable training and is doing more harm than anything else, because agriculture is a science, just like physics and chemistry.

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The second area where policy affects biotechnology is in the regulatory arena. How do we promote science, its related technology and the freedom necessary to develop to its fullest potential for the common good, while at the same time

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assuring a skeptical public that their safety is being looked after ? Almost every technology we have ever had faced the same crisis. We live in a society that is dominated by science and technology. Yet not even 5 percent of the population is equipped to understand scientific reasoning or the scientific method. This failure has led to a blurring of the distinction between science and technology. Science is the production of new knowledge, while technology is the application of knowledge to the production of some product. Most people do not distinguish between the two, creating many problems for new technologies.

Science, in and of itself, is more or less innocuous. As soon as it leads to technology, it is not necessarily innocuous. No society yet has learned how to accurately predict the consequences of new technologies. Herein lies the dilemma—there are inherent risks to the pursuit of new knowledge. The risks are greater, however, if we do not continue the pursuit. Biotechnology is the new knowledge that is with us now, and the question becomes a matter of risks balanced against benefits. Biotechnology is currently facing this challenge.

Biotechnology can make enormous contributions to basic research in agriculture, in medicine, industry and a host of other areas. Equally enormous, at least to a few, is a host of related environmental, regulatory, ethical and national security concerns. Scientists involved with recombinant DNA work have been aware since the inception of their craft of the potential for both good and bad. Scientists have taken a very strong initiative on their own in monitoring their research in what is generally regarded as a responsible and effective manner. The early concerns in biotechnology were with the safety of the experiments themselves—assuring that they were appropriately contained, and that even if organisms did happen to escape, that they could not survive and affect the environment. History has shown that this phase was handled very well. The creation of the P4 laboratory achieved total containment.

Commercial biotechnology is now poised to contribute dramatically to health and welfare worldwide. Yet the public's understanding of the underlying science and its grasp of biotechnology's capabilities and limitations has not kept pace with and undermines the industry[1]s development. Currently, science, technology and its practitioners are both admired and mistrusted, and this does not bode well for public policy decisions.

Concerned about correcting the widespread misperceptions surrounding biotechnology, I will stress three fundamental facts:

l- Today*s biotechnology is only one point in a long continuum of scientific inquiry reaching back to beer and bread making thousands of years ago. Selec-

tive breeding by early farmers was genetic engineering—we have long used biotechnology.

2- Biotechnological techniques are largely extensions of processes that occur naturally. Clones are not artifacts cooked up in a test tube—cloning abounds in nature as a means of asexual reproduction. Identical twins are clones. Moreover, evolution has not stopped. Mutation is an integral part of all life processes, and not an invention by scientists. What is new is our growing ability to simulate nature in ways that can offer enormous benefits.

3- Biotechnology does not describe a single procedure or process, but encompasses a diversity of means for using living matter to develop useful products. Recombinant DNA technology, the aspect most familiar to the public, is but one of the vehicles for product development.

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We must have as a mission the demystification of biotechnology for the public at large. Speak to the Kiwanis Club, the Lions Club whenever and wherever you have the opportunity. Biotechnology, particularly genetic engineering, must be demystified to ensure that the public accepts it.

Without public acceptance, support and encouragement, the applications of genetic engineering may be regulated out of existence. The long regulatory cycles that we currently experience will crush smaller biotechnology companies, thus focusing development in the hands of a few large companies who have the funding and time to wait out the regulatory storm. It is crucial that scientists and informed lay people emphasize to the public that genetic engineering is as natural as plant breeding. Genetic engineering is basically a method to crossbreed or hybridize different organisms, to graft one or several genes from one organism to another. The plant and animal breeder has a limited number of useful traits—genes—with which to work into his crop seeds and animals. Genetic engineering offers a much larger menu of potentially useful traits and can enormously speed up the process of hybridization.

A corn plant with one gene changed by genetic engineering is still a corn plant, with one gene changed. It is not anything else, and to compare it to an alien introduction such as kudzu or the gypsy moth is scientifically absurd. If we are to banish pestilence and hunger from this planet, we must all be tireless opponents of divisive and unfounded rhetoric and proponents of scientifically based realism. We must demystify biotechnology and get people to understand the difference between facts and fantasy, between evidence and anecdote, between experiments and experiences.